ECoBA Evaluates Actual Savings of Conservation Programs

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The ECoBA (evaluation and cost benefit analysis) Project was born of the need for hard data related to the actual savings being achieved through municipal water conservation programs. Programs are typically selected based upon predicted savings and are rarely evaluated after the fact.

ECoBA's goal was to provide decision makers with an additional tool to use when deciding which water conservation program to implement first or next, or which to eliminate.

The ECoBA Project analyzed utility records of 89 cases (one year of a particular water conservation program) in 44 programs from 11 states, primarily in the West. Programs included water audits, landscape retrofits, washing machine rebates, toilet rebates and replacements, and conservation device giveaways. In addition, a limited number of rate change, ordinance, and conservation class programs were reviewed, but insufficient data were available for direct comparison. The methodology examined participants' water use two years prior to and two years after the program. Their water use was then compared with that of a control group (average use for the entire utility or a subset population) to assess the amount of water savings that could be attributed to the program.

Besides determining actual water savings achieved, the program was designed to establish costs to the utility, other funders, and customers to attain those water savings.

We looked in-depth at the water use patterns of the customers who took advantage of the conservation programs and the persistence of their water savings through time, and compared the actual water savings with standard predicted savings. The economic analysis focused on the cost to save an acre foot of water and the cost to the utility per participant. Results are shown in the table and charts on the next page. A few key or unexpected findings from the ECoBA Project are notable.

We were surprised by the difference in the water savings achieved by **toilet rebate** programs versus **toilet distribution** programs. This may be because distribution programs allow a utility to assert total quality control by offering only highly efficient models, ensure that toilets are installed properly, and also check for leaks or other conservation opportunities in the household during installation.

	Average water savings per participant (gal/yr)	Average cost to utility/funder per participant	Actual water savings relative to predicted	Average lifetime cost per acre-foot saved	expected lifespan (years)
Toilet distributions	26,890	$331	228%	$181	20
Landscape conversions	21,900	$650	N/A	$1,099	10
Audits	8,690	$116	159%	$1,284	5
Toilet rebates	7,440	$151	63%	$436	20
Washing machine rebates	3,180	$144	64%	$404	12
Device giveaways	-6,690	$7	N/A	$457	5

Toilet giveaways was the clear winner in terms of cost and water savings, while the savings from some other devices was less clear.

It was also noteworthy how few savings (if any) were achieved from **device giveaway** programs.

Landscape conversion and **audit programs** were so variable in their costs and savings achieved that program managers should be especially cautious in structuring and targeting these types of programs.

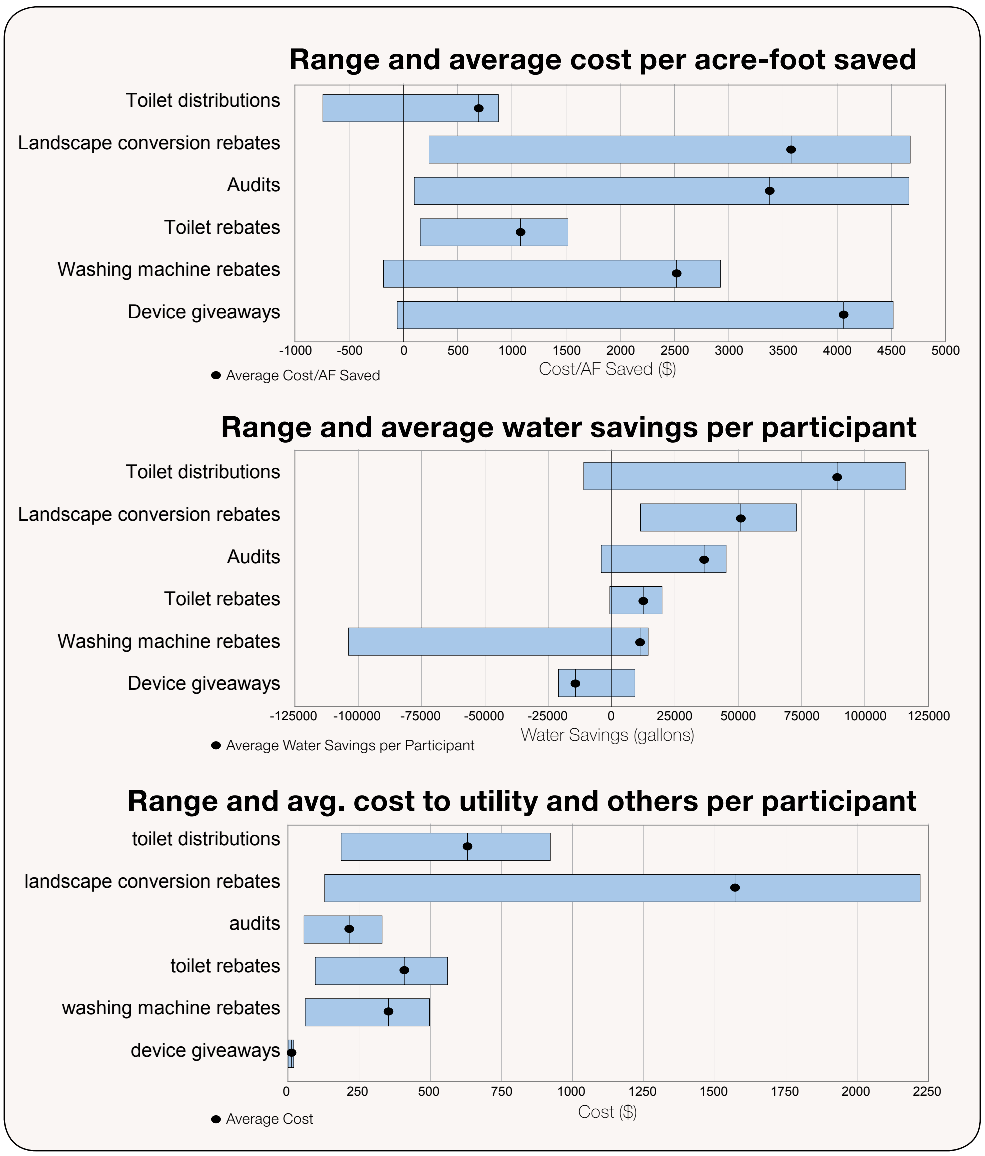
Negative water savings per participant indicates that control group water use decreased more (or increased less) than participant water use. This was especially evident with **washing machine rebates** (second chart below): prior to acquiring new washing machines, participants used 130 percent of the amount of water used by the typical single family customer in their utility; in the two years following installation of the new machines, the same customers used 132 percent of the amount the control group used.

The impact of this research is beginning to be felt in the water conservation and resource management communities. The U.S. Bureau of Reclamation recently decided to fund toilet replacement programs rather than toilet rebates, and the Metro Water Improvement District in Tucson is in the process of revamping its conservation programs to focus on toilet replacements in older housing units and providing incentives for the new high-efficiency toilets (one gallon or less per flush).

Lessons learned from ECoBA and recommendations to utilities include:

- *Initiate detailed tracking* of program participation, including water consumption for participants and similar non-participating households, as well as for the whole customer class.
- *Evaluate programs*. Be willing to change direction, doing more of what is working and less of what is not.
- *Improve communication* between conservation staff and the rest of the water resource management team, particularly data managers.

The ECoBA Project was funded by Water CASA members (Community Water of Green Valley, Flowing Wells Irrigation District, Metro Water Improvement District, Town of Marana Water Department, Town of Oro Valley Water Utility), U.S. Bureau of Reclamation, University of Arizona TRIF funds, Arizona Department of Water Resources, and Tucson Water. Contact Val Little at vlittle@u.arizona.edu.



Hydraulic Conductivity Loss Leads to Use of Ex-Situ Treatment Cell

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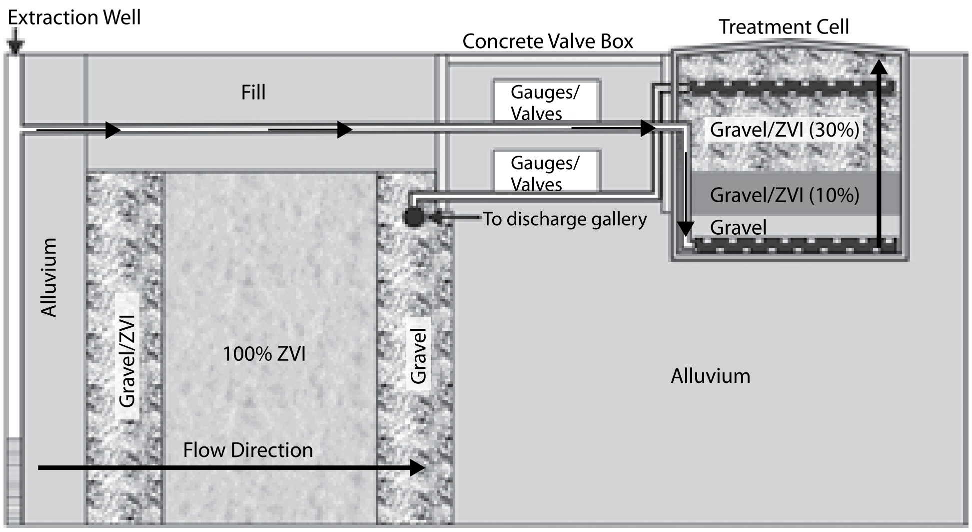
Performance monitoring of a permeable reactive barrier (PRB) that has operated since 1999 at a former mining/milling site near Monticello, Utah, recently revealed significant reductions in hydraulic conductivity throughout the treatment area. The PRB had successfully reduced high concentrations of radioactive and metal contaminants to below maximum contaminant levels (MCLs), but the decrease in hydraulic conductivity caused groundwater to mound upgradient of the PRB. The U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency subsequently investigated the system and identified a supplemental remedy for groundwater treatment.

The original PRB was 100 feet wide by six feet thick, and was designed to treat groundwater containing uranium, selenium, vanadium, and other contaminants with concentrations exceeding MCLs by as much as a factor of 100. The PRB was constructed with a 2-foot-thick upgradient zone containing 13 percent (by volume) zero-valent iron (ZVI) mixed with pea gravel and a 4-foot-thick downgradient zone containing 100 percent ZVI. Contaminant concentrations in groundwater exiting the PRB remain below MCLs after seven years of operation; however, hydraulic conductivity in the downgradient ZVI zone has decreased by nearly three orders of magnitude.

Analysis of cores collected from the reactive media in 2002 indicated that more than 8,000 kg of calcium carbonate and 24 kg of uranium- and vanadium-bearing minerals had deposited in the PRB. Chemistry data provided an estimated average groundwater flow rate of 6 to 9 gallons per minute (gpm) during the first years of operation. Additional coring 18 months later showed continued precipitation and a groundwater flux of approximately 5 gpm. Electron microprobe analyses indicated that ZVI grains in the upgradient gravel/ZVI zone had corroded but much of its original mass remained. Iron oxides and carbonates had replaced and coated the ZVI grains and filled interstitial space.

Four gas-injection slug tests conducted between June 2000 and November 2005 showed hydraulic conductivity values remained nearly constant within the upgradient alluvium and the upgradient gravel/ZVI zone but decreased two orders of magnitude in some wells within the 100 percent ZVI zone during that period (see chart, next page).



Contaminated groundwater at the Monticello site is now extracted from a well upgradient of the PRB and routed to an adjacent ex-situ treatment cell.

Supplemental Cell Installed

After 44 months of operation, upgradient groundwater mounding had advanced to within approximately one foot below ground surface. In response, an extraction well was installed immediately upgradient of the PRB and a supplemental ex-situ treatment cell was installed downgradient of the PRB in June 2005. The treatment cell is a 6-foot-diameter by 5-foot-deep concrete cylinder with a reactive medium consisting of 2 tons of ZVI mixed with pea gravel (see diagram above) varying from 0 to 30 percent ZVI, chosen to maximize treatment capacity and minimize loss of hydraulic conductivity. Contaminated groundwater is pumped into the bottom of the treatment cell and allowed to flow up through the reactive media at a typical flux of 4 to 5 gpm.

In the first five months of operation, groundwater levels upgradient of the PRB decreased to 5 feet below ground surface; hydraulic conductivity of the treatment cell has not changed. Weekly and monthly groundwater analyses show that uranium concentrations entering the system range from 200 to 350 micrograms per liter (µg/L) and that effluent water meets Utah groundwater standards (less than 45 µg/L). Concentrations of selenium currently shows a decrease from 25 µg/L in the cell influent to 0.7 µg/L in the effluent.

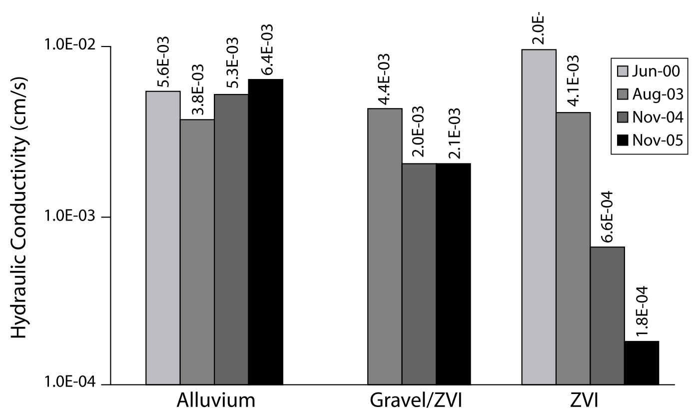
Treatment Cell a Cheaper Alternative

The PRB effectively treated groundwater for approximately four years. Limited data from the supplemental treatment cell indicate that the system may be capable of similar performance. The cell treated 1.7 million gallons of contaminated groundwater during its first year of operation, while the PRB treated an estimated 8.2 million gallons of water during its six years of operation.

Cost analysis indicates that treatment cell construction was completed for approximately $50,000 compared to more than $1 million for the original PRB. To achieve a comparable level of confidence, performance monitoring also will cost significantly less for the treatment cell than for the PRB. In addition, treatment cell decommissioning costs are estimated at less than $5,000, while PRB decommissioning costs are estimated at more than $50,000.

DOE and EPA will consider replacing the ZVI reactive media in the treatment cell (for less than $2,000) when the cell no longer adequately treats the contaminants of concern or when hydraulic conductivity in the cell decreases. Replacement of reactive material in the PRB gate, which would cost in excess of $700,000, is not considered a viable alternative.

View full article at Technology News and Trends, *www.cluin.org. Contact Paul Mushovic at mushovic.paul@epa.gov, Tim Bartlett at tim.bartlett@gjo.doe.gov or Stan Morrison at stan.morrison@gjo.doe.gov.*



Long-term monitoring showed unanticipated reductions in hydraulic conductivity within the 100 percent ZVI zone of the Monticello PRB.